Robot Programming with Lisp

1. Introduction, Setup

Arthur Niedzwiecki

Institute for Artificial Intelligence
University of Bremen

20th October, 2020

General Info

- Lecturer: Arthur (PhD student at IAI)
- Correspondence: `aniedz@cs.uni-bremen.de`
- Dates: Thursdays, 14:15 - 15:45, 16:15 - 17:45
- Language: English and German
- Credits: 6 ECTS (4 SWS)
- Course type: practical course
- Course number: 03-IBVP-RPWL (03-BE-710.98b)
- Location: TAB Building, Room 0.30 EG

Plan

Introduction

Course Content

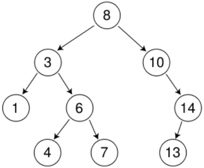
Organizational

Assignment

Course content

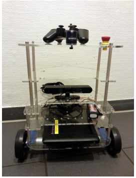
Common Lisp

Artificial Intelligence



Robot Operating System (ROS)

Robot platform



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Applications using / written in dialects of Lisp:
Emacs, AutoCAD, Grammarly, Mirai (Gollum animation), Google ITA (airplane ticket price planner AI), DART (DARPA logistics AI), Maxima (computer algebra system), AI frameworks, NASA satellites ...

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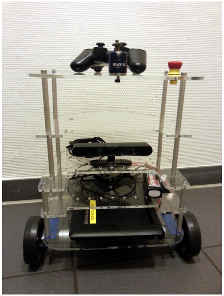
- *De facto* standard in modern robotics

TortugaBot

- 2 controllable wheels
- 2D laser scanner
- Thinkpad E485 PC with bluetooth
- PlayStation joystick



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- ROS supports a number of languages
- Lisp is good for rapid prototyping
- It is more suitable for symbolic reasoning and AI
- There are existing robot programming languages in Lisp that automate decision making

Rough schedule

Assignments (single, this year)

- Introduction & Setup
- Lisp basics
- OOP & Failure Handling
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- Search Algorithms

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- 2D world of *turtlesim*
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Project (groups, Jan-Feb '22)

- Controlling TortugaBot
- Reading sensor data
- Collision avoidance
- Heuristic decision-making
- The big day: competition

Course Goals

You will learn / improve your skills in the following:

- Common Lisp, of course
- Git
- Functional programming
- Cognitive robotics
- Jupyter Notebook
- Docker
- Linux
- ROS (for future roboticists)
- Emacs (the IDE for Lisp devs)

...and get to play with a real little robot!

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- Solutions are discussed in the tutorial.
- Can get 60 of 50 points in homework (can skip one homework).
- Bonus points for very good homework solutions.

Scheinbedingungen Summary

- Graded homework every week until January, then group project
- Live presentation of the group project, individual grading
- 50 homework + 50 group project = 100 points for final grade
- homeworks have 60 points total, so there's a buffer if you miss one
- at least 25 points from the homeworks
- Final grade: 50 of 100 points - 4.0, 100 of 100 points - 1.0.
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Links

- This lectures website:
  https://ai.uni-bremen.de/teaching/cs-lisp-ws22
- Git reference book:
  https://git-scm.com/docs/gittutorial
- Lisp books:
  http://landoflisp.com/, http://www.paulgraham.com/onlisp.html, http://www.gigamonkeys.com/book/
- Emacs cheat sheet:
  https://www.gnu.org/software/emacs/refcards/pdf/refcard.pdf

Info summary

Next class:

- Date: 27.10. **???**
- Time: 14:15 (14:00 - 14:15 for questions)
- Place: same room (TAB 0.30)

Assignment:

- Due: 26.10, Wednesday, 23:59 **???**
- Points: 3 points
- For questions: write me a mail
  or ask your colleagues in the StudIP forum

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Assignment goals

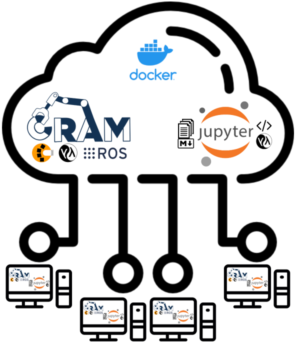
Set up your working environment

Set up your Git repository

Get comfortable with Jupyter

Cognitive Robotics for everyone

Docker is a manager vor virtual machines.
DockerHub hosts the virtual machine, ready to be downloaded



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- MacOS
  If you have an ARM M1 CPU check out these notes here:
  `https://docs.docker.com/desktop/mac/apple-silicon/`

Task 1 Check: Test if Docker works

- On Linux and older installations:

  ```
  docker-compose version
  ```

- On newer and other (e.g. Windows, Rosetta):

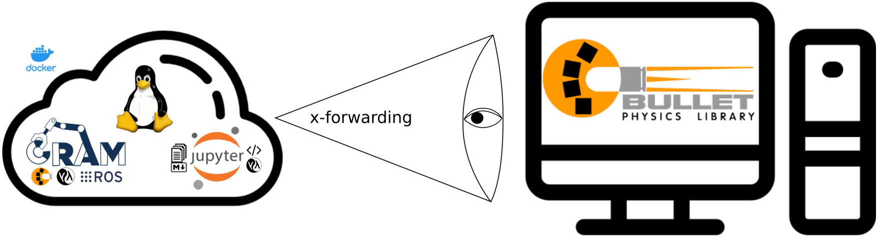
  ```
  docker compose version
  ```

- Check rights

  ```
  docker run hello-world
  ```

Task 2: Configure X-Forwarding

Visual applications run in the virtual machine (Docker container) using X, which is a visualization technique for Linux systems. Docker can't visualize itself, so we forward the Bullet Physics Simulation to your PC.



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- MacOS
  ?

Task 3: Git

Git provides version-control of changing code. A Git repository is a storage place for code. With Git it is easy to manage group projects and keep track of changes.

`https://git-scm.com/book/en/v2/Getting-Started-Installing-Git`

Using Git via CLI provides the best experience to understand how it works. There are also Git clients with a GUI. This lecture will only cover the CLI commands for Git.

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- Define a remote target with the address of your new GitHub repo:

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cd lisp_course_exercises
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Replace YOUR_GITHUB_USERNAME in the following command.

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git remote add my https://github.com/YOUR_GITHUB_USERNAME/lisp_course_exercises.git
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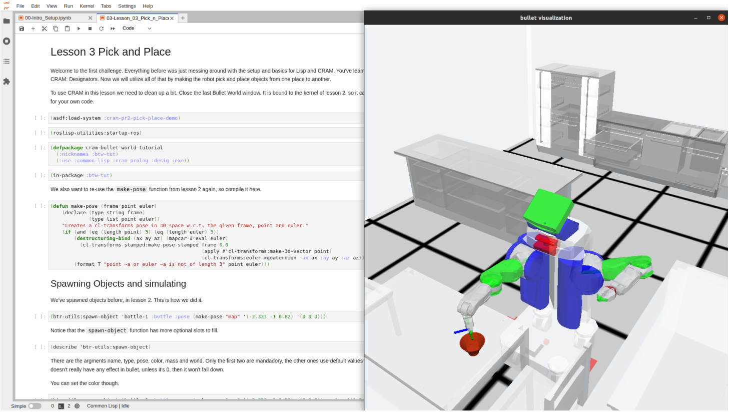
- Upload the files to your new GitHub repo:

  ```
  git push -u my main
  ```

Task 5: Get into Jupyter & Test your setup

Jupyter combines code with documentation. Each lesson is a mix of Markdown plain text, and executable Lisp code.



Lesson 3 Pick and Place

Welcome to the first challenge. Everything before was just messing around with the setup and basics for Lisp and CRAM. You've learn
CRAM: Designators. Now we will utilize all of that by making the robot pick and place objects from one place to another.

To use CRAM in this lesson we need to clean up a bit. Close the last Bullet World window. It is bound to the kernel of lesson 2, so it ca
for your own code.

```
[ ]: (asdf:load-system :cram-pr2-pick-place-demo)
```

```
[ ]: (roslisp-utilities:startup-ros)
```

```
[ ]: (defpackage cram-bullet-world-tutorial
       (:nicknames :btw-tut)
       (:use :common-lisp :cram-prolog :desig :exe))
```

```
[ ]: (in-package :btw-tut)
```

We also want to re-use the `make-pose` function from lesson 2 again, so compile it here.

```
[ ]: (defun make-pose (frame point euler)
         (declare (type string frame)
                  (type list point euler))
         "Creates a cl-transforms pose in 3D space w.r.t. the given frame, point and euler."
         (if (and (eq (length point) 3) (eq (length euler) 3))
             (destructuring-bind (ax ay az) (mapcar #'eval euler)
               (cl-transforms-stamped:make-pose-stamped frame 0.0
                                                        (apply #'cl-transforms:make-3d-vector point)
                                                        (cl-transforms:euler->quaternion :ax ax :ay ay :az az))
             (format T "point ~a or euler ~a is not of length 3" point euler)))
```

Spawning Objects and simulating

We've spawned objects before, in lesson 2. This is how we did it.

```
[ ]: (btr-utils:spawn-object 'bottle-1 :bottle :pose (make-pose "map" '(-2.323 -1 0.82) '(0 0 0)))
```

Notice that the `spawn-object` function has more optional slots to fill.

```
[ ]: (describe 'btr-utils:spawn-object)
```

There are the argments name, type, pose, color, mass and world. Only the first two are mandadory, the other ones use default values
doesn't really have any effect in bullet, unless it's 0, then it won't fall down.

You can set the color though.

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  Linux: `xhost +local:docker`
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- In Jupyter, navigate to "lectures/tutorials/00-Intro_Setup.ipynb"
  Go through the setup guide. If the demo at the end runs, your good!

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- Finally, to **upload** your local commits to the Github server, push the changes upstream:
  ```
  git push
  ```

Troubleshoot

For troubleshooting, consider the setup documention here:

`https://github.com/cram2/cram_teaching#readme`

or use the forum to work with your colleagues or write me a mail.

Q & A

Thanks for your attention!